national accelerator laboratory

EXP-62
June 21, 1974

ACCELERATOR EXPERIMENT: Status of Main-Ring Correction Magnet Systems

Date: June 20, 1974

For some time, correction of resonances in the main ring at low energies has been a one-man project and very few people are aware of what systems are used for which resonances. The purpose of this note is to summarize some information on these systems. It is hoped that any change in the future be made a "public" record.

Calibration

1. Quadrupole (iron-core) : $(B'\ell) = 0.244$ kG/amp

$$B_y = B'x \; ; \; B_x = B'y$$

2. Skew Quadrupole (iron-core) : $(B'\ell) = 0.064$ kG/amp

(air-core) : $(B'\ell) = 0.0244$ kG/amp

$$B_y = - B'y \; ; \; B_x = B'x$$

Only iron-core skew quads are now used in the main ring.

3. Sextupole (iron-core) : $(B''\ell) = 8.52$ kG/m/amp

(air-core) : $(B''\ell) = 0.466$ kG/m/amp

$$B_y = (B''/2)(x^2 - y^2) \; ; \; B_x = B''xy$$

4. Skew Sextupole (iron-core) : $(B''\ell) = 5.80$ kG/m/amp

(air-core) : $(B''\ell) = 0.856$ kG/m/amp

$$B_y = - B''xy \; : \; B_x = (B''/2)(x^2 - y^2)$$

5. Octupole (iron-core) : $(B'''\ell) = 152.4$ kG/m^2/amp

(air-core) : $(B'''\ell) = 16.8$ kG/m^2/amp

$$B_y = (B'''/6)(x^3 - 3xy^2) \; ; \; B_x = (B'''/6)(- y^3 + 3yx^2)$$

Only iron-core octupoles are now used in the main ring. Regular quadrupoles and sextupoles are measured in the unit

1 unit ≡ 5 amp/127 or 127 units ≡ 5 amp.

For octupole and skew quadrupole currents, use 1 volt ≡ 1 amp.

Various Systems

For each system, correction magnets are placed at the same stations in all six sectors.

1. $2\nu_x = 39$: iron-core quadrupoles at #36 and #42.

   strength : A36 = C36 = E36 = -B36 = -D36 = -F36

   A42 = C42 = E42 = -B42 = -D42 = -F42

   Equivalent total stopband width (6/18/74 setting) = 0.0677.

2. $2\nu_y = 39$: iron-core quadrupoles at #37 and #45.

   Arrangement of quadrupole strength is the same as above.

   Equivalent total stopband width (6/18/74 setting) = 0.00724.

These two systems are not independent of each other. For example, the setting on 6/18/74 shows that quadrupoles at #36 and #42 are contributing significantly for correcting $2\nu_y = 39$. Quadrupoles at #45 were not used at all.

3. $\nu_x - \nu_y = 0$: skew iron-core quadrupoles at #14, #27 and #43

   The strength is the same for all 18 magnets.
   This system is presently not very important.
   The current is ~ 0.5 amp. At 8 GeV,

$$|\Sigma(B'\ell/B\rho)(\beta_x\beta_y)^{1/2}| = 0.1035.$$

4. $3\nu_x = 58$: regular iron-core sextupoles at #28.

   strength : A28 = D28, B28 = E28, C28 = F28.

   6/18/74 setting : At 8 GeV ($B\rho$ = 296.5 kG-m),

$$|\Sigma\ \beta_x^{3/2}(B''\ell/B\rho)\ \exp\ (i\ 58\phi_x)| = 218.8\ m^{-1/2}.$$

Contributions from air-core sextupoles at #27 and #35 are minor.

5. $\nu_x + 2\nu_y = 58$: regular air-core sextupoles at #27 and #35.

Arrangement of sextupole strength is the same as above.

Contributions from iron-core sextupoles at #28 are significant.

6/18/74 setting : At 8 GeV,

$$|\Sigma\ \beta_x^{1/2}\ \beta_y(B''\ell/B\rho)\ \exp\ (i\ 58\phi)| = 48.21\ m^{-1/2}$$

where $\phi \equiv (\phi_x/3) + (2\phi_y/3)$ is used.

6. $3\nu_y = 58$: skew air-core sextupoles at #14 and #39.

Arrangement of sextupole strength is the same as above.

Contributions from iron-core sextupoles at #17 and #22 are important.

6/18/74 setting : At 8 GeV,

$$|\Sigma\ \beta_y^{3/2}(B''\ell/B\rho)\ \exp\ (i\ 58\phi_y)| = 55.4\ m^{-1/2}.$$

7. $2\nu_x + \nu_y = 58$: skew iron-core sextupoles at #17 and #22.

Arrangement of sextupole strength is the same as above.

Contributions from air-core sextupoles at #14 and #39 are minor.

6/18/74 setting : At 8 GeV,

$$|\Sigma\ \beta_y\beta_y^{1/2}(B''\ell/B\rho)\ \exp\ (i\ 58\phi)| = 130.3\ m^{-1/2}$$

where $\phi \equiv (2\phi_x/3) + (\phi_y/3)$ is used.

8. Average octupole field ; iron-core octupoles.

QF stations #17, #22, #28, #36, #42

QD stations #21, #23, #25, #27, #33, #35, #37, #39

Strengths of these two groups can be adjusted separately. The function of this system is to eliminate the dependence of tunes on betatron oscillaton amplitudes. However, the effectiveness of the system has not yet been explored exhaustively. At present, only the QF group is used with the current of (2.5 ~ 4) amp. If one takes the emittance 1.5π mm-mrad, 4 amp in the QF group introduces a tune spread $\delta\nu_x \simeq 0.009$.

There are 160 additional regular iron-core sextupoles distributed around the ring for correcting the momentum dependence of the tune. Since an attempt to create higher multipole fields in these sextupoles is now in progress, this system will be reported later when new performance data become available.

S. Ohnuma